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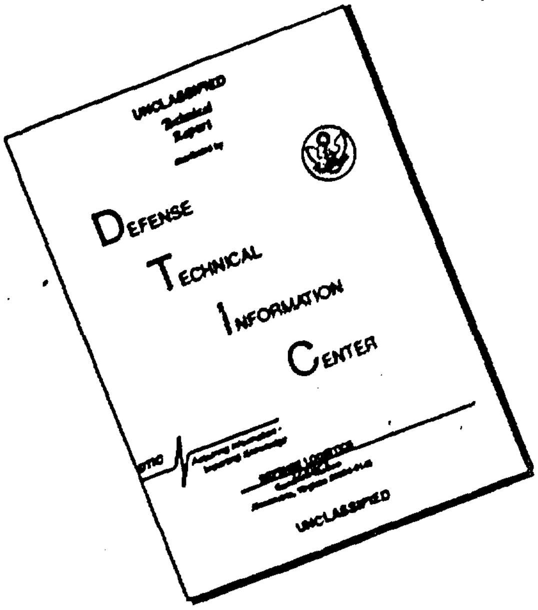

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The Marine Laboratory
Institute Of Marine Science
UNIVERSITY OF MIAMI

63-5

PROGRESS REPORT

July 1963

INVESTIGATIONS OF
AMERICAN TROPICAL AND SUBTROPICAL SEAS

Sponsored by the

OFFICE OF NAVAL RESEARCH

Nonr 840(01) and Nonr 4008(02)

June 1, 1962 through May 31, 1963

MIAMI 49, FLORIDA

UNIVERSITY OF MIAMI

INSTITUTE OF MARINE SCIENCE

THE MARINE LABORATORY

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REPORT FOR

JUNE 1, 1962 THROUGH May 31, 1963

1 Rickenbacker Causeway
Miami, Florida 33149

F. G. Walton Smith
Director

ML 63382

Institute of Marine Science
The Marine Laboratory
University of Miami

INVESTIGATIONS OF AMERICAN TROPICAL AND SUBTROPICAL SEAS

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Nonr 840(01) and Nonr 4008(02)

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INTRODUCTION

The major part of the research in the Division of Physical Sciences, the Institute of Marine Science of the University of Miami, is supported by the Office of Naval Research under Contract No. Nonr 4008(02). The research of 12 senior staff members is partially supported from these funds. The report covers the period from 1 June 1962 through 31 May 1963. The area covered varies geographically from Cape Canaveral in the north, to the equatorial Atlantic in the south, and from the eastern part of the Gulf of Mexico to Exuma Sound in the Bahamas. One hundred eighty ship days were utilized for the work reported.

The waters of the Tongue of the Ocean and Exuma Sound were studied by several expeditions conducted by Mr. Murice Rinkel and Mr. Saul Broida. The Florida Current was investigated on a monthly basis, the Bahamian waters on five cruises, and the Gulf of Mexico on 14 cruises. The study of the direct current flow in the Straits, the Yucatan Channel, and Northwest Providence Channel was pursued by Mr. William Schmitz and Mr. John Schenck. An attemp was made to study the physical and chemical changes of a water parcel moving through the Straits by means of following a buoy as far as Cape Canaveral.

Chemical studies have been conducted for productivity, content of organic matter (dissolved and particulate), the distribution of certain trace elements, and the influence of evaporation in the surface spray on the fractionation of elements contained in sea water. The surface-spray problem was attacked by Dr. Paul Antal in a new laboratory study. Dr. Eugene Corcoran and Mr. James Alexander developed new methods for the determination of copper, nickel, and iron, the distribution of which was correlated with organic matter. Mr. Max Flandorfer assumed responsibility for the hydrographic laboratory, which analyzes on a routine basis, for salinity, oxygen, phosphate, and alkalinity.

The work on chemical and mineralogical composition of sediments was supervised by Dr. Gene Rusnak with the help of Mr. Oiva Joensuu and Mr. William Warneke. New methods were developed for both chemical and mineralogical determinations. Most notable was the attempt to study the components of the sediments, their genesis and diagenesis, by a new fractionation method further developed by Dr. Antal. Specific attention was given to determining absolute ages of sediment strata and exact rates of sedimentation in an effort to obtain a better understanding of the sedimentation processes and the geochemistry of the Pleistocene period.

Micropaleontological research was centered on the study of Foraminifera, their morphology, as dependent on environmental factors, and the geochemistry of their shells. Benthonics as well as pelagic foraminifers were studied by Mr. James I. Jones and Mr. Wayne Bock in the environment close to the Institute. The paleotemperatures obtained by determination of O^{18}/O^{16} ratios by Dr. Cesare Emiliani were compared with the recent ecology of the organisms in consideration of variations of their morphology with temperature. Coccolith studies have been conducted on cores from the Caribbean by Mr. Carel Cohen.

The mechanism of sedimentation was studied by Dr. Rusnak. Special attention was given to the variation of the rate of sedimentation with climatic fluctuations and the frequency of turbidity flows in the Tongue of the Ocean. The diagenesis of carbonate sediments in water depth below 200 m. was investigated on cores from our area of immediate interest. The chemical composition of sediments was studied by Mr. Joensuu on samples prepared by Dr. Antal and by Dr. Peter Wangersky of Yale University. By applying various approaches to fractionation of samples, we sought to increase the information output concerning the origin of the components and the diagenetic changes.

The physical aspects of the sea floor were studied by Dr. Robert Hurley who used precision echo-sounding and extensive bottom photography in Straits of Florida. An extensive coverage of ripple marks indicated a rather strong bottom current. Some evidence was also found of occasional changes in current direction. The morphological work was geared mainly to the study of the meso and micro features of the sea floor, since these promised to give a better understanding of the forces in action and to explain the processes shaping the sea floor.

The data reduction group under the direction of Mr. Broida and Mr. Donald Eger established several programs for the IBM 1620 computer. These programs have reduced the work load, increased the output, and expedited the publication of oceanographic data.

Considerable effort was given to the development of new instruments, devices, and techniques of general oceanographic character. Mr. Shale Niskin developed a series of water samplers for different purposes, ranging from two-liter sterile biosamplers to large-scale, 500-liter C^{14} samplers. A new device for nets and other towed instruments proved to be effective in most severe sea conditions. The azimuth-and-slope indicator was redesigned to an appropriate size and adjusted to diversified uses; mooring and anchoring devices were developed; and Mr. Morton Kronengold completed a prototype of an acoustic current meter with high time resolution and accuracy. The development of this current meter without inertia and indicating the flow in a small volume now permits the study of the particle velocity in waves.

Abstracts of the results obtained by group and individual efforts, as indicated above, are included in this report to present in more detail the scope of the oceanographic research program at the Institute of Marine Science as conducted with the Geophysical Branch of the Office of Naval Research.

CHEMICAL OCEANOGRAPHY AND MARINE GEOCHEMISTRY

Kinetics and Physical Chemistry of Sea Water Surface Films - P.S. Antal

In sea-bubble spray, the anions and cations of sea water are separated because of charge differences. The anion ratio, however, is found to change in sea foam, aerosols, and precipitation. The combination of effects of redox potential, association reaction, and charge separation during the observation makes conclusive explanations difficult. Therefore, experiments were designed to give only the influence of bubble formation and at the same time allow a control of all factors involved.

In a very simple, self-cleaning bubble spray chamber, aerosols are produced, yielding a few ml spray under controlled conditions. Quantitative collection as ice in a dry-ice cooled impinger excludes contamination completely; differential flame spectrophotometry serves for direct determination of cation/sodium ratios with the required high accuracy.

The separation effects for the major and minor components of sea water, in particular the nonvolatile part (cations), were investigated. Under more stringent control (exclusion of oxidizing agents), the behavior of anions can be studied.

Very encouraging preliminary results have been obtained. At small fluxes, approaching those occurring in natural bubble spray, the univalent cations K and Cs are fractionated slightly relative to Na, as can be expected from their rather similar hydration. Large depletion factors ($\frac{Me}{Na}$ +) spray/ ($\frac{Me}{Na}$ +) charge were found for the strongly hydrated bivalent cations Mg, Ca, and for the chemically similar Li.

As described above, a shield was used to stop the big drops of effervescence resulting in preferential collection of microdrops and generally in lower spray yields (µl/cuft gas) and lower salt concentrations (µg/ml = ppm).

From the two modes of operation, the fractionation effect can be demonstrated to be mainly due to microdrops originating presumably from a surface phase. The computed change in composition of large droplets is much smaller or even reversed; this is in accord with previously recorded observations that jet drops are formed more or less from the bulk solution.

The changes of relative Ca and Mg content are just opposite to those postulated by Fonselius for the transition sea water → aerosol → precipitation. The most likely explanation seems to be that the bubble mechanism in the sea surface is not that of a pure solution. This is concluded from the simultaneous enrichment of complexing surfactants in precipitation. Certainly the addition of such components will completely reverse the spray behavior of alkali and alkaline earth cations. This mechanism could well supply sufficient lithium to account for its observed presence in the upper atmosphere.

The partial separation of cations obtained may be regarded as a separation of the equilibrium surface phase that seems to form sufficiently fast; the lower separation factors for jet drops can be explained from their lower content of surface phase without special need to invoke relaxation phenomena. Change of cationic composition (and slightly larger effects in primary anion separation) will occur in similar processes in nature.

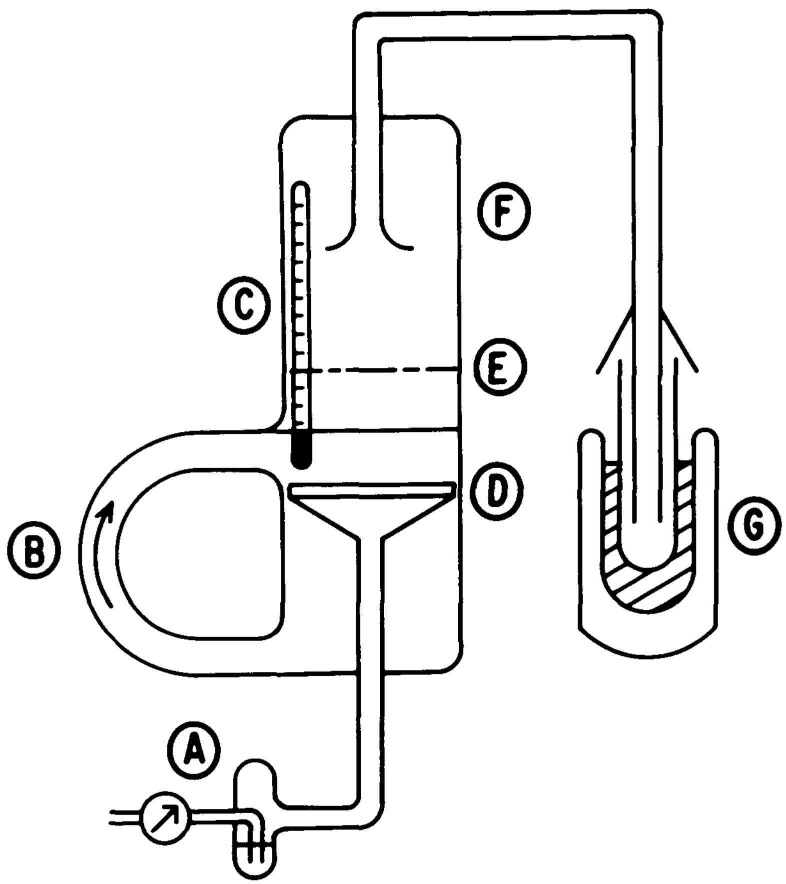
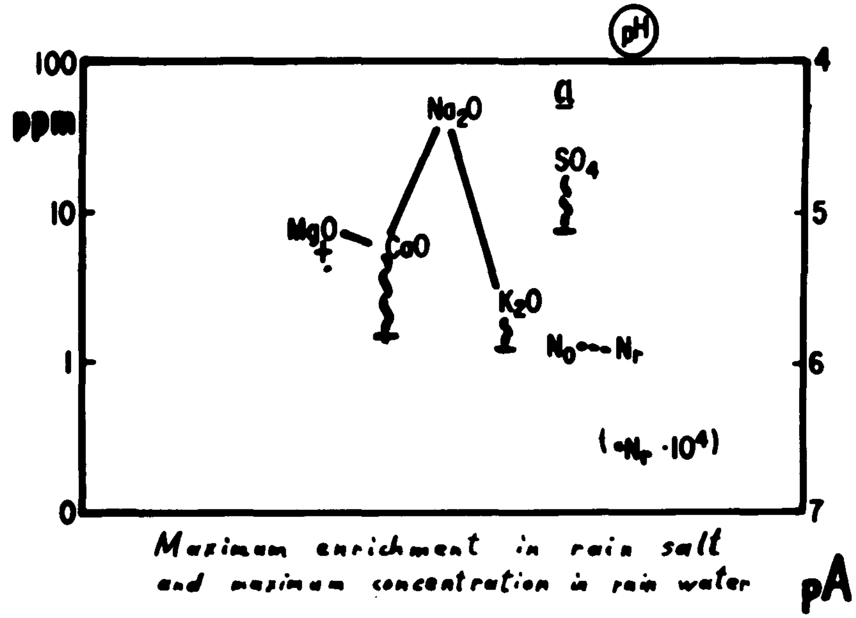
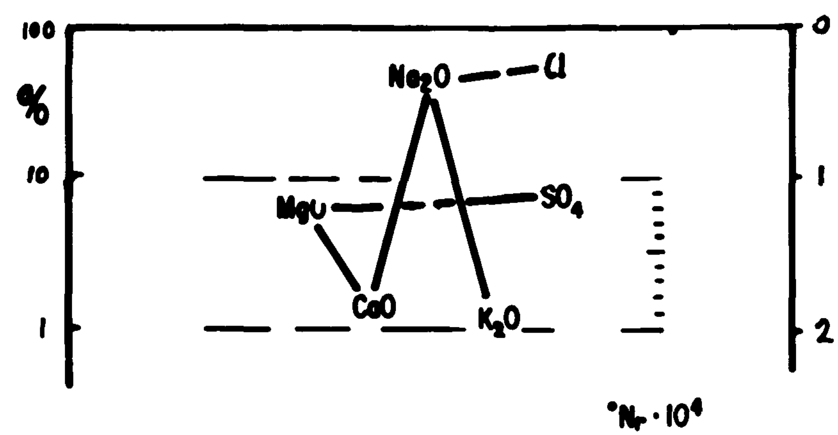


FIG. 1: PYREX GLASS CHAMBER -
A Pressure Gage and Flowmeter
B Heating Coil
C Thermometer
D Pyrex Frit (exchangeable)
E Optional Shield
F Intake
G Cold Trap Impinger -78°C



Maximum enrichment in rain salt and maximum concentration in rain water



MAJOR ELEMENTS IN SEAWATER SALT (34.3 ‰ S)

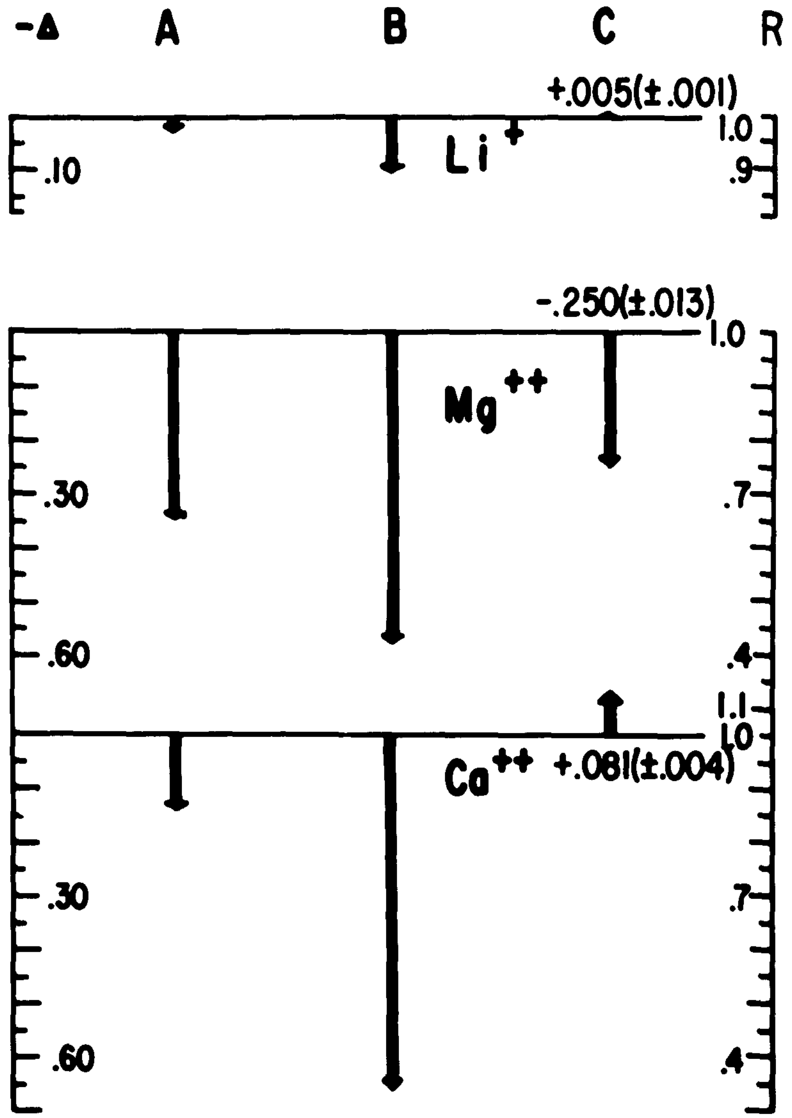


Fig. 2: Relative Change Δ of Li^+, Mg^{++}, and Ca^{++} Concentrations in Salt Transport By Bubble Spray.

A: Total Spray Collected
B: Microdrops Collected
} artificial seawater of 36, 24‰ salinity, spiked with 240 ppm each of Li^+, Rb^+, Cs^+ - nitrogen flux .53 cm sec^{-1}; 22-23°C.

$$\Delta = \frac{(c/Na^+)_{spray}}{(c/Na^+)_{sol}} - 1$$

C: Computed Change for Large Drops Only

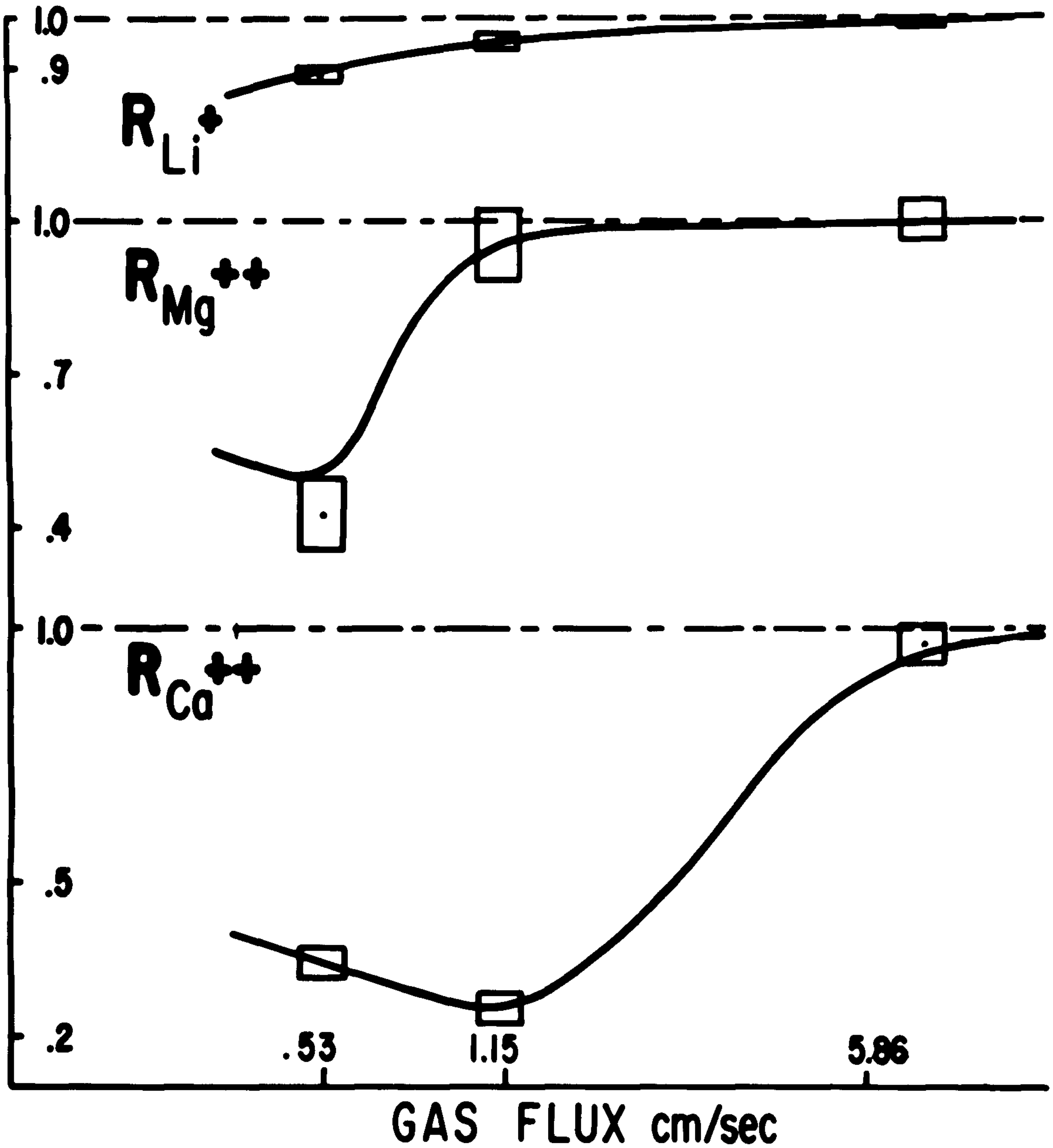


Fig. 3: Microdrop Transport of Li^+, Mg^{++}, and Ca^{++} - Influence of Nitrogen Bubble Flux On Separation Factors R. 36,24‰ Artificial Seawater (21 - 23 °C).

Figure 4

High speed photomicrograph of bubble production in artificial sea water (millimeter scale on left)

Submitted for publication

ANTAL, P.S.
Cationic Composition of Sea Salt in Bubble Spray

Primary Production and Distribution of Trace Elements - E.F. Corcoran and J. Alexander

Research during the past year has been concerned with primary production in the tropical and subtropical waters of this area and the parameters that influence the production. Nutrients, certain trace elements, their distribution, chemical complexing, and concentration by organisms have been determined.

Development of methods for the direct measurement of ionic copper and iron in sea water permitted the determination of vertical and horizontal distribution of these ions across Straits of Florida. Iron was about equally distributed between a soluble organic complex and particulate. An investigation into the source of high concentrations of particulate iron found at the Cat Cay Station revealed that the Cat Cay Station received a mixture of both Yucatan and Old Bahama Channel water.

Copper was found to exist primarily as a soluble organic complex. This soluble organic complex had a concentration about 80 times that of the particulate copper and about eight times the concentration of ionic copper. Nickel and cobalt were precipitated as carbonates and their concentrations determined by the extraction of organic complexes and calorimetric analyses. Their distribution followed closely the distribution pattern of copper in sea water. Cobalt had about ten per cent the concentration of nickel. Results of this work show the possibility of distinguishing water types by particulate metal content (especially copper).

Since copper and iron (and possibly nickel and cobalt) were found to be necessary in the biosynthesis of chlorophyll, an investigation was made of the relationship of phytoplankton to the trace metals. It was found that while there were changes in phytoplankton populations with season, the distribution of the trace metals remained the same. This would seem to indicate that these trace elements are not limiting to production. When the diurnal production of chlorophyll was compared with the concentration of copper and iron, no direct relationship was found.

Most of the unialgal cultures of open-sea phytoplankton have been made bacteria-free and are now being grown in a defined medium. This development has made possible their use in long-term studies on the uptake of radionuclides from sea water and we have confirmed the fact that organisms are able to select definite radionuclides from the sea water (*Gymnodinum simplex* refuses strontium, while *Katodinium rotundata* concentrates it).

The research into the kinds and concentrations of volatile organics in sea water has been continued. The calibration of the chromatographic instrumentation with pure compounds showed the need for columns that give sharper separations of simple organics with similar chemical structure, and columns that are unaffected by traces of water.

Sediments from Straits of Florida have been shown to contain from one to two per cent organic matter with relatively high concentration of chlorophyll derivatives and carotenoid pigments. This correlates with the findings of Thalassia in photographs of the bottom. The organic content was based on both carbon and nitrogen determinations. A gas partitioner was used successfully in the determination of organic carbon by wet combustion. This instrumentation detects both carbon dioxide and carbon monoxide directly and is not affected by other gases. Particulate carbon has also been analyzed by this procedure, and with slight modification, the soluble organics in sea water can be determined directly.

Previous investigations have shown that the vertical mixing of the surface waters rarely attains the depth of the euphotic zone. Hence, a rapid turnover of nutrients takes place in these surface waters. This fact led to an investigation of the form of nutrients utilized by the phytoplankton population of tropical waters. Varying amounts of organic and inorganic phosphates were used in the culture of Gymnodinum simplex. It was found that this organism preferred the organically bound phosphate over the inorganic; in fact, some indications of growth inhibition were exhibited when concentrations above 0.3 μg-at/L of inorganic phosphate were used, while lower concentration had no effect on the organisms' growth. As the tropical waters are specific because of the absence of vertical winter mixing, the requirement for organic phosphate may be the specific feature of tropical phytoplankton.

Publication

ALEXANDER, J.E. and E. F. Corcoran
1963. The distribution of chlorophyll in the Straits of Florida. Limnol. & Oceanog. 8(2):294-297.

Submitted for publication

CORCORAN, E. F. and J. E. Alexander
The distribution of certain trace elements in tropical sea water and their biological significance.

Carbonate Chemistry on Bahama Banks - F.F. Koczy and E.D. Traganza

The calcium precipitation on the Bahama Bank was studied on three cruises during the last year. Attention was given to the chemical composition of water with regard to calcium, magnesium, alkalinity, productivity, salinity, and temperature. The changes in composition were studied in respect to the motion of water into the bank and of the white clouds on the bank. It was found that the situation changes drastically with the seasons. The winter cooling of the bank water is remarkable and there does not seem to be any precipitation of calcium. During the other two cruises, the calcium content was found to decrease in relation to the increase in chlorinity content. It was interesting to note the increase of Mg in relation to chlorinity when the salinity was increased by evaporation. It seems that magnesium is not lost to the same degree with sea spray as is chloride. It may be that we must look for an indicator element that is not lost by biological or physical-chemical processes in the water mass before we can determine the evaporation. Salinity data may be not accurate enough for our study.

The artifical production of white clouds (whitings) by stirring up sediment was tried but without success. Since we believe that the formation of these clouds is intimately connected with the precipitation of carbonate, the mechanism of their formation seems to be an integral part of the investigation.

Geochemistry of Sediments - G. A. Rusnak and O. I. Joensuu

Those deep-sea cores that appear to contain a continuous undisturbed stratigraphic section offer a unique opportunity to study incipient diagenesis as a function of time. Except for small, periodic temperature variations of the bottom water in response to glacial and interglacial cycles (probably not exceeding 3°C) and a negligible pressure difference between top and bottom of even the longest cores, the only variables are time and sedimentation intensity. While the shells of pelagic Foraminifera are calcitic, other carbonate elements are aragonitic or high magnesium calcites. Some of these have been identified by X-ray techniques and indicate possible transitions to low magnesium calcite or solution of aragonite with depth in the core and therefore in terms of time. In the deep-sea cores examined, incipient dolomitization has not been observed as yet.

Sand layers (both foraminiferal and silicate) as well as distinct changes in core lithology have been described in several of the cores collected during the CARIB Expedition. The analytical techniques for the study of sand mineralogy are relatively straightforward and require little or no modification beyond routine methods now available. The finer components, however, require special treatment and enrichment of those components that are present in small amounts only. Methods for this kind of analysis are now in the process of development and promise to provide reproducible quantitative data. These techniques apply largely to the separation of the amorphous and poorly organized silicates as distinct from the carbonate components. Methodology for the analysis of the carbonates has already been developed and refined to provide reliable quantitative data.

During the past year, we have performed extensive elemental analyses of the coarse fraction of several carbonate deep-sea cores, and intensive elemental analyses on the three main fractions (coarse carbonate fraction; fine carbonate fraction; noncarbonate fraction) in a few, carefully selected deep-sea cores, and extensive elemental analyses were performed on five fractions separated from a single core (A254-BR-C). These fractions are coarse carbonates, total carbonates plus ion exchangeables, reducible materials, interstitial water, and residues. The interstitial water was analyzed for Na, Cl, Ca, and Mg; the coarse carbonate fraction was analyzed for Ca, Mg, Sr, and Mn; the total carbonate for Ca, Mg, Sr, and Mn; the reducible fraction for Fe^{+++} and Mn; and the residue for Si, Ti, Al, Fe, Mn, Mg, Ca, B, Ba, Be, Co, Cr, Cu, La, Ni, Sc, Sr, V, Y, and Zr. Mn in the carbonate phase appears to have undergone postdepositional migration, while Mg appears to migrate from the interstitial water to ion-exchange sites. The elemental composition of the residual phase (mainly clay) was remarkably constant within each core.

Trace element analyses of living and dead benthonic and planktonic foraminiferal species have been made, and will continue to be made in the future. These analyses will test existing theories of the importance of the distribution of trace elements in the shell material of these organisms in relationship to their systematics, biocoenoses, and preferred environmental habitats. From preliminary study of these data, it appears that a number of recent studies of the trace element chemistry of these forms are in error and that the values of the measurements were based primarily on the contaminants inherently present in the fossil material analyzed. The comparative studies of fossil and living species now in progress should resolve this important problem.

Publications

JOENSUU, Oiva I. and Norman H. Suhr
1962. Spectrochemical analysis of rocks, minerals and related materials. Applied Spectroscopy 16(3):101-104.

ÖSTLUND, Göte and James E. Alexander
1963. Oxidation rate of sulfide in sea water, a preliminary study. Jour. Geophys. Res. 68(13).

OLAUSSON, E. and Oiva I. Joensuu
1962. X-Ray diffraction analysis of calcium carbonate. Marine Laboratory Technical Report 62-10 submitted to the Office of Naval Research.

Paleotemperature - C. Emiliani

Oxygen isotopic analysis of the deep-sea cores collected in the course of our CARIB Expedition to the Caribbean (November-December 1960) and of other deep-sea cores collected for us by R/V ATLANTIS of Woods Hole in the Caribbean has been continued and is nearing completion. Analysis of the longer cores has permitted us to reconstruct a possibly continuous temperature record ranging from the present to an estimated age of about 530,000 years ago. Fairly elaborate techniques for inter-core correlations were used to achieve this reconstruction.

Oxygen isotopic analyses of the *Patella* and *Trochus* shells from the Haua Fteah Cave (Cyrenaica) and the Arene Candide Cave (Italian Riviera) have been completed. These two caves contain unusually fine sections of continental deposits ranging from Paleolithic to Roman times. These deposits include stalagmite layers numerous artifacts, charcoals, large amounts of *Patella* and *Trochus* shells (food refuse), and a Neanderthaloid jaw in the lower strata of the Haua Fteah Cave. Incremental oxygen isotopic analysis of the shells has yielded a reconstruction of the variation of the summer maxima and the winter minima during the past 100,000 years. The results indicate that the lower layers of the Haua Fteah Cave were deposited during the last interglacial age (i.e. from 100,000 to about 70,000 years ago), that the intermediate layers were deposited during the postglacial. The Arene Candide Cave showed a similar sequence. Many of the younger layers of the two caves have been dated by the Washington and Cambridge laboratories using the C^{14} method. Using this time scale, it appears that temperature began to rise steeply about 11,000 years ago; it reached a maximum (higher than today) at about 6,000 years ago; it decreased to a few degrees centigrade about 4,500 years ago; and finally it rose to the present values.

Publication

ROSHOLT, J.N., C. Emiliani, J. Geiss, F.F. Koczy, and P.J. Wangersky 1962. Pa^{231}/Th^{230} dating and O^{18}/O^{16} temperature analysis of core A254-BR-C. Jour. Geophys. Res. 67(7):2907-2911.

Foraminifera Studies - J. I. Jones and W. Beck

The micropaleontological research group has continued to pursue its primary objective of developing criteria for paleoecologic interpretation of deep-sea core and other geologic material by study of the biologic relationship of living assemblages of these organisms. A number of individual but closely related studies are being conducted relative to this major goal. The seasonal vertical, and zoogeographic distributions of living planktonic foraminiferal populations from Florida Straits, the Bahamas and Caribbean are being analyzed and their variations interpreted in terms of their physical and chemical environment. It has been possible to delineate precisely the preferred depth ranges for a number of species and also to analyze the diurnal pattern for the group as a whole. The observed ranges, in a number of cases, closely approximate those hypothesized earlier by Emiliani which were based upon isotopic analysis of fossil shell material. Maximum population values were found in the upper waters during the day, with the organisms seeking lower water levels at night. An average vertical migration of approximately 60 meters (50-80 meter range) was exhibited. Seasonal highs have been found to occur in July and January in Florida Straits, showing a general correspondence to maximum total phosphate values. A general agreement in vertical distribution and diurnal migration exists between Florida Straits and the Bahamas. Maximum populations have been found to occupy the upper 150 meters in Florida Straits, the Bahamas, and Caribbean. A secondary high population level, but of much lower value than that of the upper waters, has been found in the 750-1000 meter range in the Caribbean.

Studies of subspecific morphologic variation within selected species of benthonic and planktonic Foraminifera have provided encouraging results, indicating that detailed studies of this variation may provide yet another tool for interpretation of ancient environmental situations. This variation, measured on shell structures, can be analyzed statistically and compared to environmental variability. It can be shown that this morphologic variation is directly related to any factor or combination of factors present in the environment. This will provide another useful tool for the micropaleontological paleoecologist.

Observations and photomicrography of living planktonic Foraminifera on shipboard presented a number of problems, the major ones of which have been solved during the last year. Continued efforts will be made to refine the techniques already developed in this phase of study. The first shipboard photomicrographs of feeding activity, chamber formation, and reproduction of these organisms have been made. As relatively little is known of the biology of this group, observation and documentation of their life processes are of considerable importance to a better understanding of these features.

A new double-trip mechanism has been developed that will allow far greater precision and sample reliability than has been the case in prior investigations of marine plankton. This device allows a plankton net to be lowered in a closed, nonfishing position, opened at a selected depth at which it is towed, and then closed before retrieval. In combination with a time-depth recorder and a flow meter, the samples obtained by this technique exhibit a higher degree of reliability than those previously collected by less precise methods.

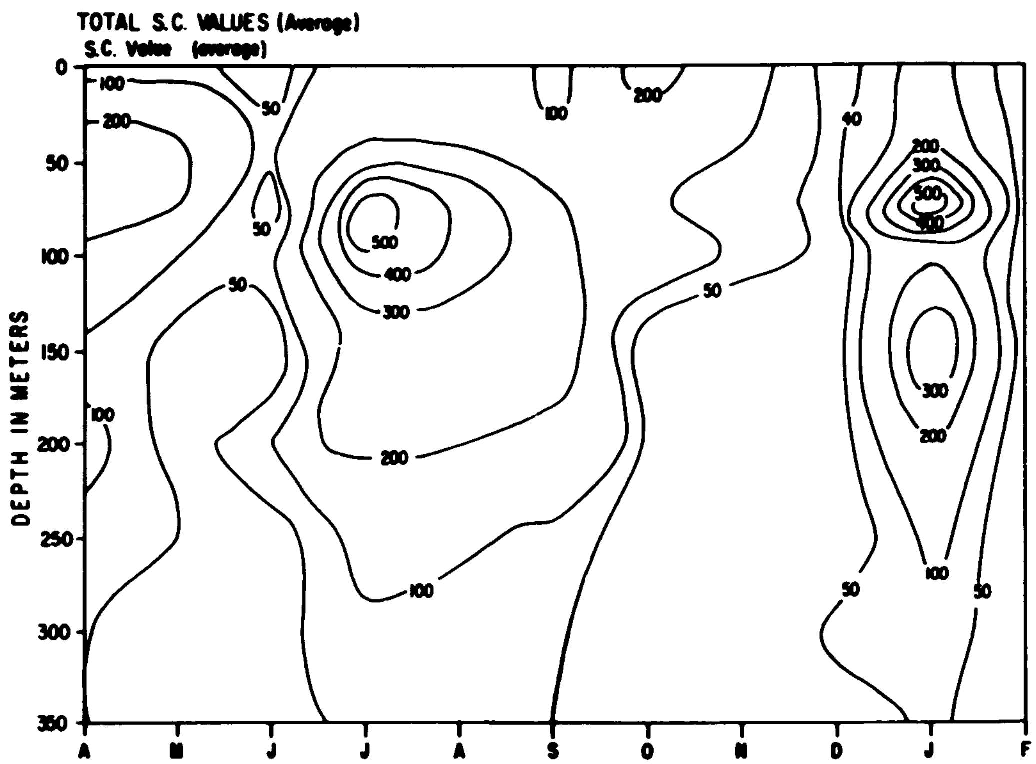


Figure 1
Total standing crop (specimens/1000m^3 of water filtered) of planktonic Foraminifera in the upper 350 meters of water at the Cat Cay station over an 11 month period, showing seasonal and vertical distribution variations.

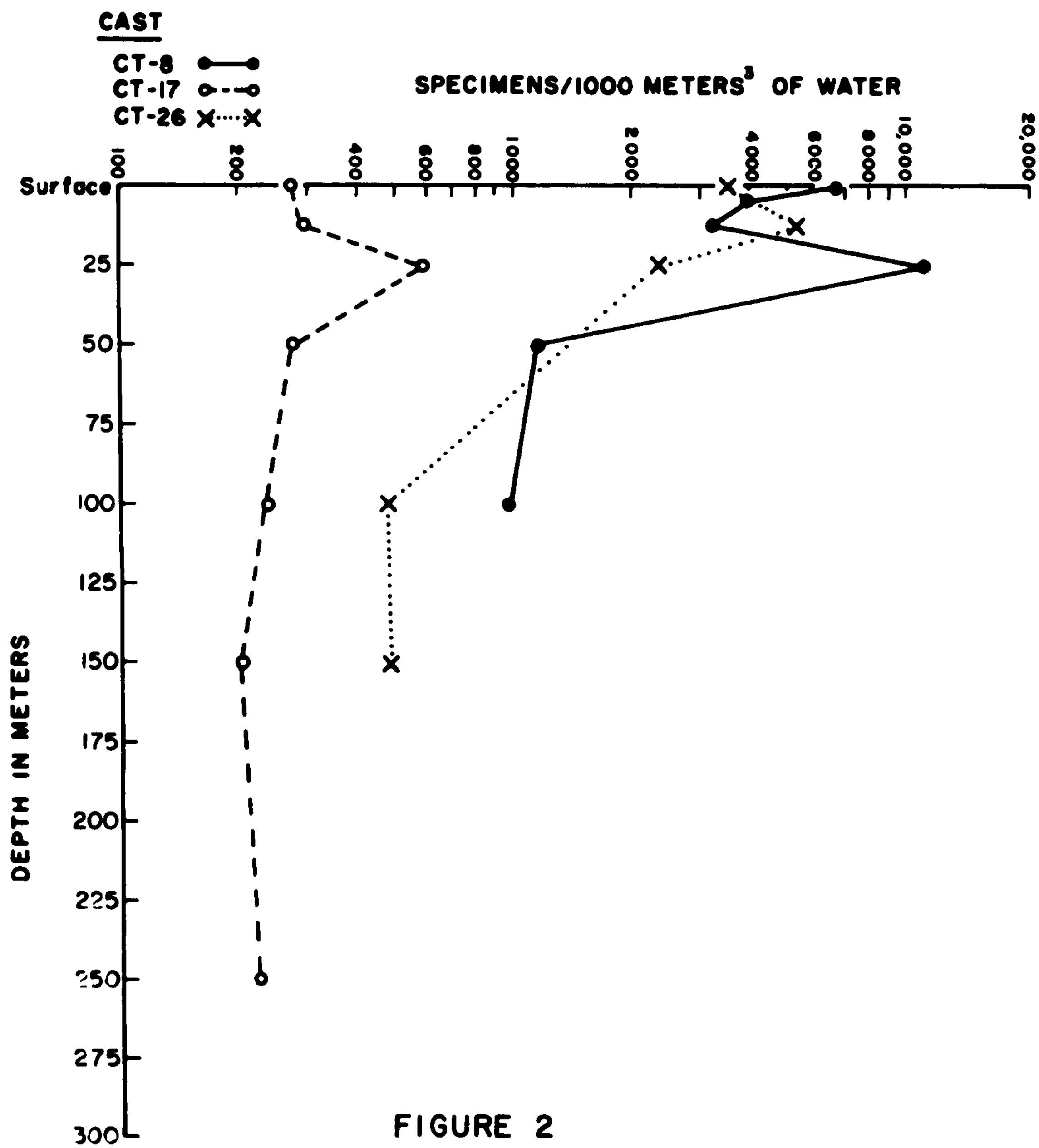


FIGURE 2

SEMI-LOG PLOT OF TOTAL FORAMINIFERAL POPULATION STANDING CROPS, SURFACE TO 250 METERS.

Standing crop values in upper waters at 3 selected Caribbean localities, showing vertical population variations. (Shows primary concentrations in upper 100 meters).

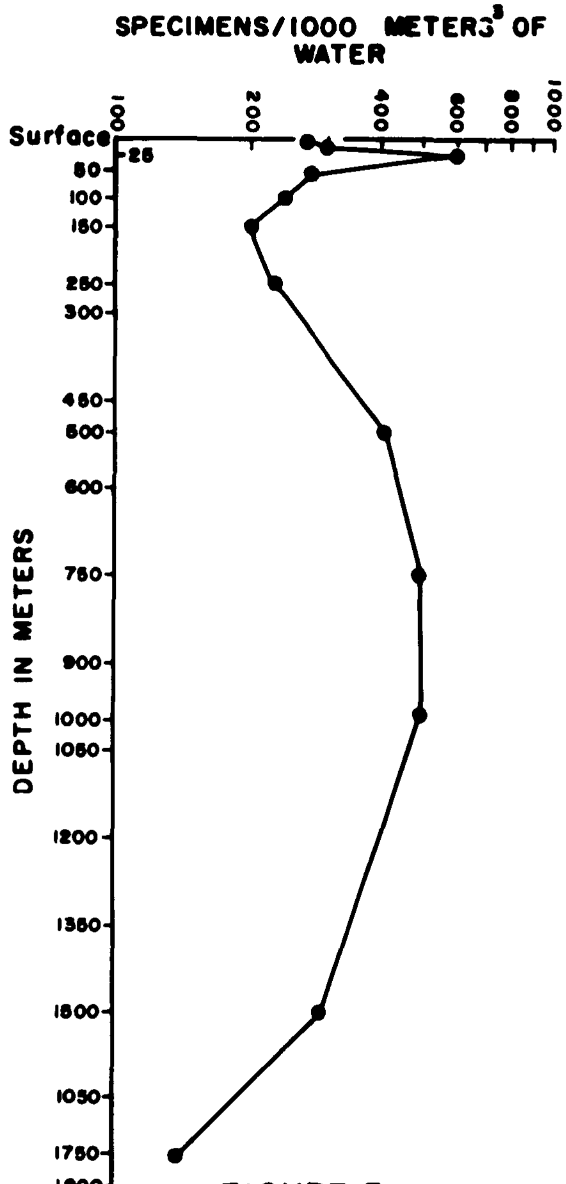


FIGURE 3

SEMI-LOG PLOT OF TOTAL FORAMINIFERAL POPULATION STANDING CROPS, SURFACE TO 1750 METERS, CAST CT-17.

Standing crop variation in the upper 1750 meters at an east-central Caribbean locality. (Shows primary high in upper waters with secondary high at 750-1000 meter level).

Submitted for publication

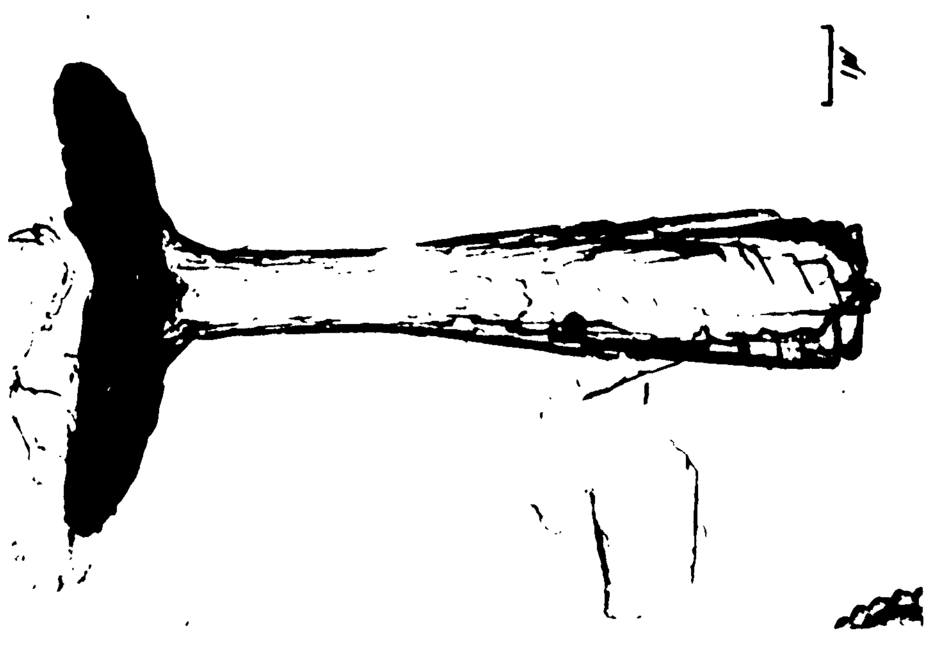
JONES, James I.
1963. The distribution and ecology of living planktonic Foraminifera of the West Indies and adjacent waters. Ph.D. dissertation, Univ. of Wisconsin.

JONES, James I. and Wayne D. Bock
Trace element distribution in some living and fossil Foraminifera.

Coccolith Studies - C. Cohen

Coccolith studies have been continued and the study of the Caribbean cores A240-M1, A254-BR-C, and CP-28 has been completed. Major emphasis has been placed on the use of this group as temperature indicators in the geologic past. A number of species have been investigated, and certain forms determined as being diagnostic of temperature minima or maxima. Several new species were erected primarily on the basis of increased morphologic information obtained by electron microscopic techniques. A number of collections were made to obtain living representatives of this group from the plankton of the Florida Current for *in vivo* studies.

Cyclococcolithus leptoporus
(Murray & Blackman) Kamptner
x 12,000



Rhabdosphaera claviger
(Murray & Blackman)
x 15,000

Submitted for publication

COHEN, C.
Coccoliths and Discoasterids from deep-sea core CP28.

Sedimentation - C. A. Rusnak

Studies of the rates of sedimentation from the Caribbean and from the Tongue of the Ocean have yielded interesting results on the variation of sedimentation with climatic fluctuations and on the frequency of periodic turbidity flows. The cores from the Caribbean indicate that the sedimentation intensity or accumulation rate varies directly with changes in paleotemperature, although there may be a short time lag between these changes. Glacial times (or cold periods) show higher rates of accumulation than do the postglacial (or earlier warm periods). The cores from the Tongue of the Ocean reveal that, in this dominantly turbidite depositional area, the frequency of turbidite deposition seems more directly influenced by the relative intensity of accumulation in the surroundings than on climatic variations, although eustatic changes in sea level do influence to a large extent the production of sediment. The results of these studies have been compared with those from other areas and are now ready for publication as Late Pleistocene Sedimentation Rates.

The radiocarbon dating required to develop these accumulation rates in this work was supported by the National Science Foundation. The basic geological and oceanographic work done in the collection and processing of this material was carried out under the support of the Office of Naval Research. A report on the megascopic description and sampling of cores has been prepared and published.

Field observations of lithology associated with various bathymetric features indicate that erosional features on the floor of the Tongue of the Ocean are not uncommon. Several channels charted in detail by Athearn indicate that their floors consist of partially lithified carbonate sediments covered by a thin layer of coarse shallow-water biogenic detritus, and foraminiferal and pteropod sands. It is suggested that these erosional features are the result of turbidity current action. Further field studies are required to evaluate this suggestion. Laboratory investigations of the differences in lithology between the soft and semiconsolidated sediment are being made to determine lithological characters and stratigraphy.

Publications

ÖSTLUND, H. Göte, Albert L. Bowman, and Gene Rusnak
1962. Miami natural radiocarbon measurements I. Radiocarbon 4:51-56.

RUSNAK, Gene A. and W. D. Nesteroff
1962. Modern turbidites: Terrigenous abyssal plain versus bioclastic basin. Com. Vol. to Dr. F.P. Shepard. (In press)

RUSNAK, Gene A., Albert L. Bowman, and H. Göte Östlund
1963. Miami natural radiocarbon measurements II. Radiocarbon 5:23-33.

RUSNAK, Gene A. and Stanley J. Luft
1963. A suggested outline for the megascopic description of marine sedimentary cores. Marine Laboratory Technical Report 63-1 submitted to the Office of Naval Research.

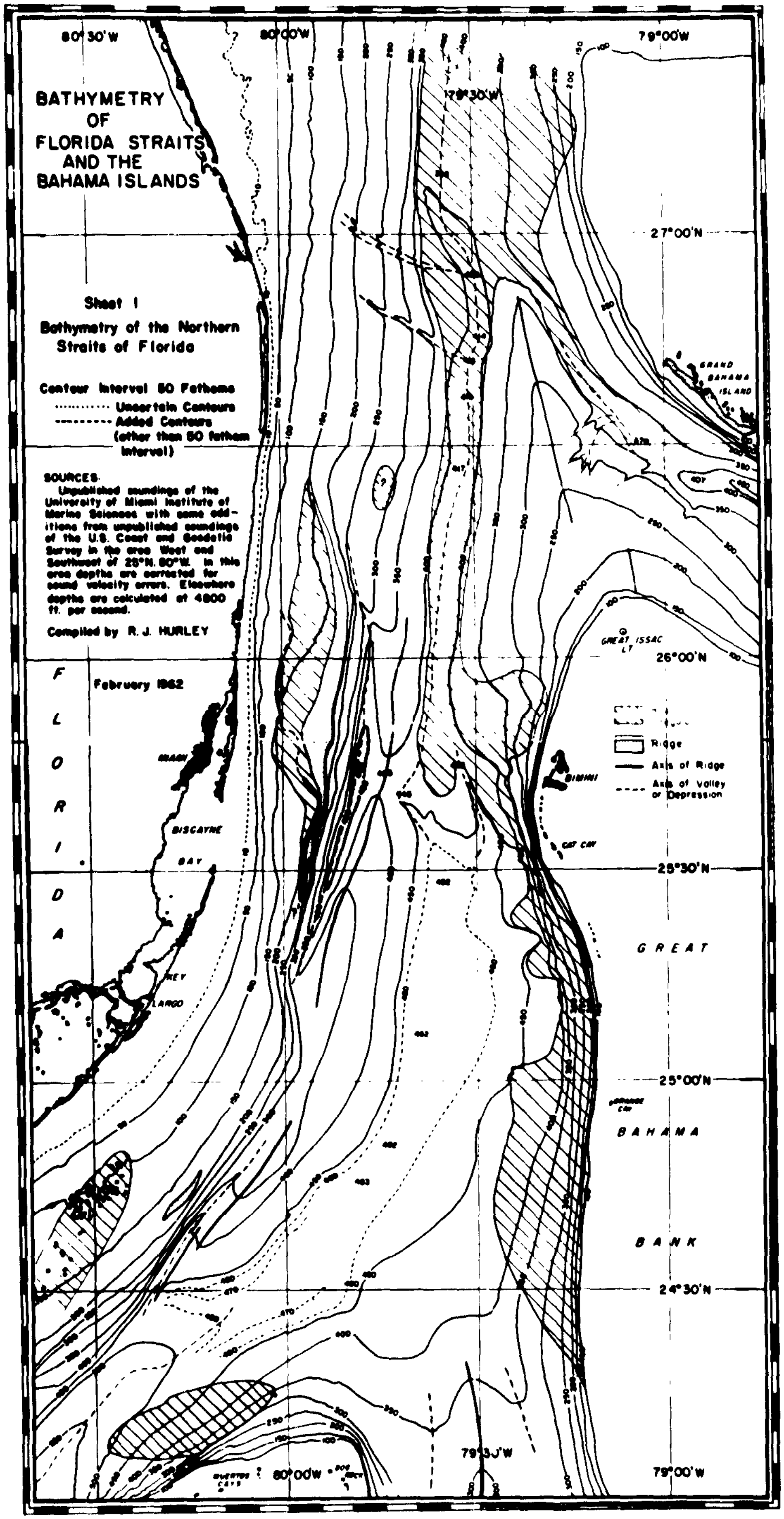
MORPHOLOGY OF THE SEA FLOOR

Topography of the Straits of Florida - R.J. Hurley

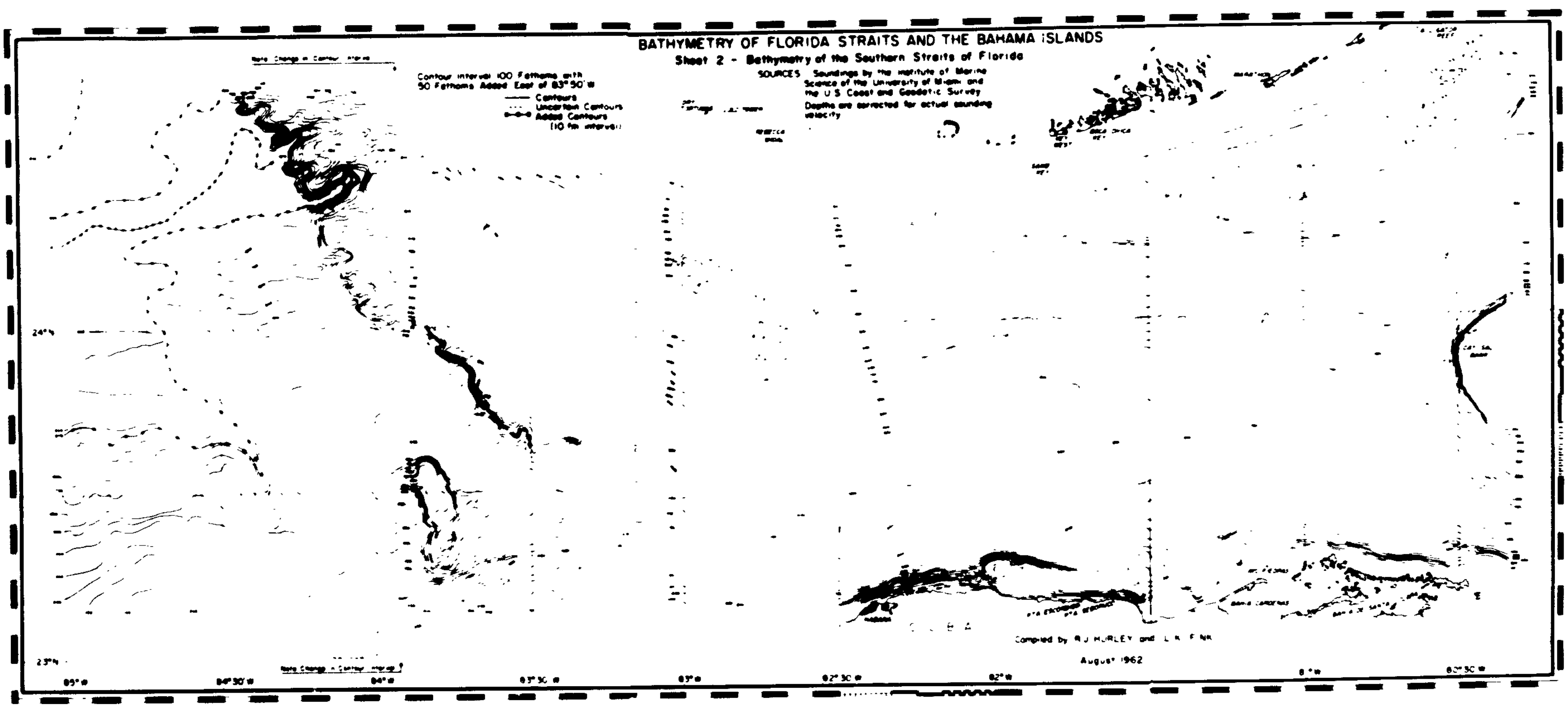
Echo soundings are fundamental to virtually all studies of the oceans. Considerable progress has been made in the last year to publish existing material and, in reducing this mass of data, to delimit more clearly critical areas and problems of fundamental interest.

During this year, charts of both Northern Florida Straits and Southern Florida Straits have been prepared, utilizing all available data. The chart of Northwest Providence Channel is near completion. Some preliminary results of this work have been presented at meetings of the Florida Academy of Sciences in February and of the American Geophysical Union in April. A detailed bathymetry and theoretical study of turbidity current flow is in press.

Emphasis of our future work will shift to the Blake Plateau, the deep-sea floor east of the Bahamas, and we plan at least reconnaissance work in the uncharted southern Bahamas. Some specialized studies will continue in the northern Bahamas, notably an exhaustive search of existing data for evidence of submerged terraces. The results of this study may require some additional echo sounding and sampling work to check our conclusions.



80°30'W
80°00'W
79°30'W
79°00'W
BATHYMETRY
OF
FLORIDA STRAITS
AND THE
BAHAMA ISLANDS
27°00'N
Sheet I
Bathymetry of the Northern
Straits of Florida
Contour Interval 50 Fathoms
Uncertain Contours
Added Contours
(other than 50 fathom
interval)
SOURCES
Unpublished soundings of the University of Miami Institute of Marine Sciences with some additions from unpublished soundings of the U.S. Coast and Geodetic Survey in the area West and Southwest of 25°N. 80°W. In this area depths are corrected for sound velocity errors. Elsewhere depths are calculated at 4800 ft. per second.
Compiled by R. J. HURLEY
February 1962
GRAND
BAHAMA
ISLAND
GREAT ISSAC
LT
26°00'N
FLORIDA
MIAMI
BISCAYNE
BAY
BIMINI
Ridge
Axis of Ridge
Axis of Valley
or Depression
CAT CAY
25°30'N
KEY
LARGO
GREAT
25°00'N
BAHAMA
BANK
24°30'N
80°00'W
79°30'W
79°00'W


BATHYMETRY OF FLORIDA STRAITS AND THE BAHAMA ISLANDS
Sheet 2 - Bathymetry of the Southern Straits of Florida
SOURCES Soundings by the Institute of Marine Science of the University of Miami and the U.S. Coast and Geodetic Survey
Depths are corrected for actual sounding velocity
Contour interval 100 Fathoms with 50 Fathoms Added East of 83°50'W
Contours
Uncertain Contours
Added Contours (10 fm interval)
Note Change in Contour Interval
CUBA
Compiled by R.J. HURLEY and L.K. FINK
August 1962
24°N
23°N
85°W
84°30'W
84°W
83°30'W
83°W
82°30'W
82°W
81°W
80°30'W

Publications

HURLEY, Robert J., Violet B. Siegler, and L. Kenneth Fink, Jr. 1962. Bathymetry of the Straits of Florida and the Bahama Islands. Part I. Northern Straits of Florida. Bull. Mar. Sci. Gulf & Carib. 12(3):313-321.

HURLEY, Robert J. 1962. Analysis of flow in Cascodia deep-sea channel. Com. Vol. to Dr. F.P. Shepard. (In press)

Ripple Marks in the Straits - R. J. Hurley

A large number of photographs (over 2,000) have been taken in Florida Straits. Preliminary results on this work have been published and presented at the meeting of American Association of Petroleum Geologists in March 1963.

Extensive current ripple marks have been found on the floor of Florida Straits near the axis at 462 fathoms. These ripples indicated a current from the south similar to that at the surface. Further, we have found some evidence that the currents, thought to be of the order of 25 cm/sec, at least occasionally reverse in direction. Also of interest is the growing evidence that these currents are very thin, perhaps no more than a few fathoms in thickness.

We are particularly anxious to pursue this work in order to determine the precise character and extent of these currents as well as their geologic significance. It is also of importance to photograph the many narrow, flat-floored valley axes that are found elsewhere in the Bahamas. These valleys form a well developed graded, dendritic drainage pattern and photographs can provide evidence on the nature and capabilities of the turbidity currents that presumably flow in them. It should be possible to learn something about the frequency, thickness, velocity, and erosive abilities of these flows.

We have recently acquired an additional Edgerton camera and light source that have undergone some specialized modifications. This equipment will permit stereographic photography and, therefore, measurements by photogrammetric methods, but it does require reconversion, unmodification, and installation of new, thick-pressure cases for use in deep water.

Ripple marks on the floor of Florida Straits,
depth 426 fathoms.

Publication

HURLEY, Robert J. and L. Kenneth Fink, Jr.
1963. Ripple marks show that counter-current exists in Florida Straits. Science 139(3555):603-605.

Investigations in the Florida Straits - S. Broida, M.O. Rinkel, W. Schmitz

The surveillance of the water masses of Straits of Florida was continued and intensified during the year. For a period of 13 months beginning May 1962, we succeeded in making monthly cruises during which most of the regular studies were accomplished in the middle of each month. The program of the survey work included temperature, salinity, content of oxygen, phosphate, and total phosphorus. Reduction of all data was accomplished by the IBM 1620 System (see section on Data Reduction). The program was enlarged during some of the cruises by a comprehensive study of productivity and trace element chemistry.

The exchange of the water masses from the coastal regions and estuaries with the Florida Current was studied. Most interesting was the observation of the discharging water masses into the current. The outflow is bent to the noth in a crescent-shaped pattern by the Florida Current. When the discharge begins to recede, bands of coastal waters are entrained by the current. During a cruise in September, these water masses were floating, ribbon-like, on top of the Florida Current. In January, however, observations near Port Everglades indicated a sinking of the discharged water as it was mixed into and carried away with the current, characteristic for the winter situation.

Three anchor stations were occupied during the last year: one in Northwest Providence Channel, one in the center of the Straits, and one on its western boundary. The main objective was the study of the current oscillations at the surface and the variation of the isotherms within BT range. The observations show that the fluctuations of the semi-diurnal character are large at the entrance of Northwest Providence Channel with an amplitude of about 100 cm/sec. Near the axis of the current, the amplitude was 50 cm/sec and on the eastern side of the Straits, only about 10 cm/sec. This would indicate the presence of a Kelvin wave with a velocity distribution, as would be expected from theory. The instability of the current was demonstrated by a linear increase of surface velocity of 50 cm/sec during a 36-hour period. The pattern of the thermocline given by the BT measurement was not affected.

Publications

BROIDA, Saul
1963. Florida Straits transports: May 1961-September 1961. Bull. Mar. Sci. Gulf & Carib. 13(1):58.

A report of data obtained in Florida Straits and off the west coast of Florida. July - December 1961. Marine Laboratory Technical Report 62-6 submitted to the Office of Naval Research.

A report of data obtained in Florida Straits and off the west coast of Florida. January - June 1962. Marine Laboratory Technical Report 62-11 submitted to the Office of Naval Research.

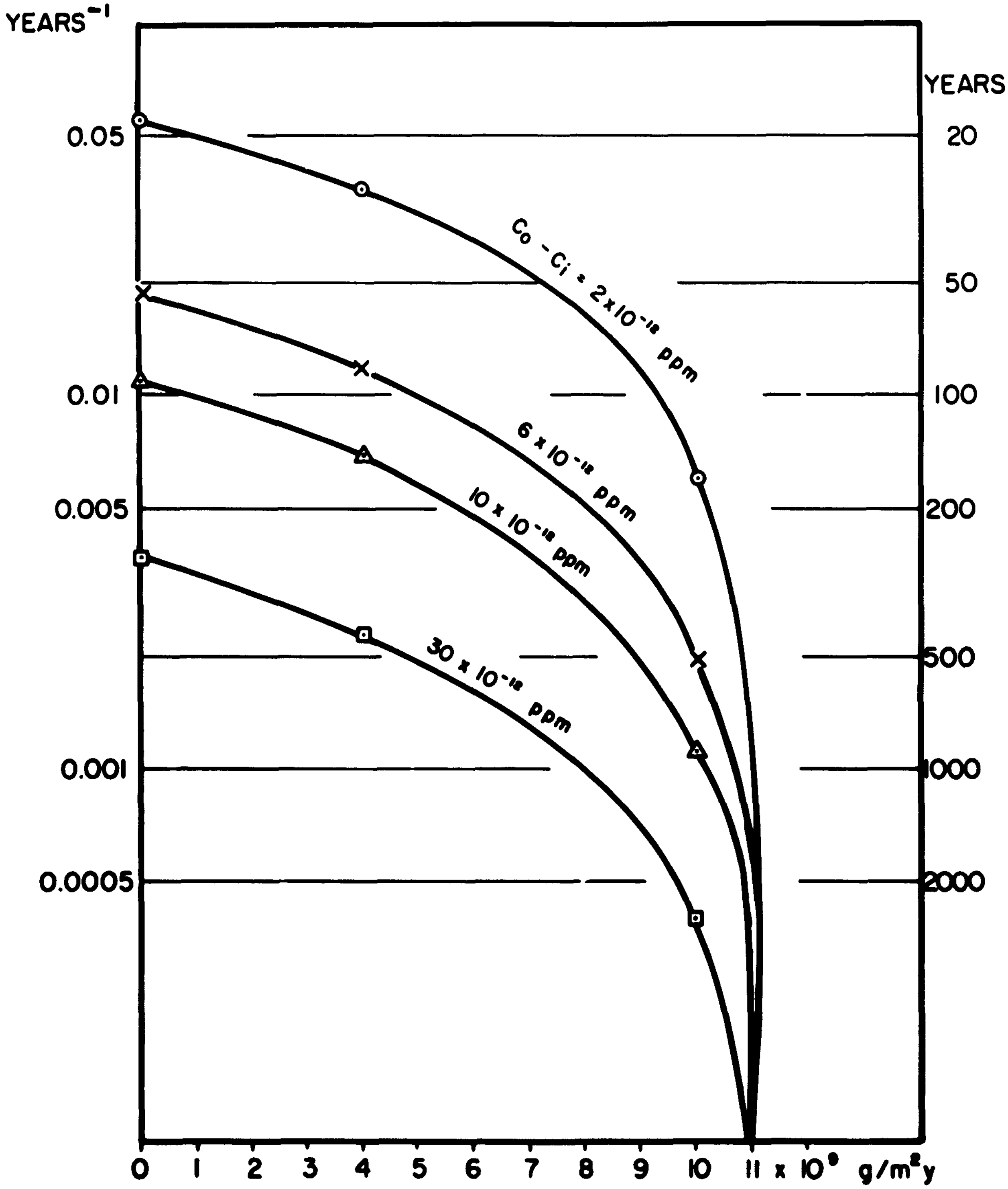
General Circulation in the Ocean - F. F. Koczy

With the use of radium samples supplied by Scripps Institution of Oceanography, the problem of the circulation of bottom water in the Indian Ocean was investigated.

It was assumed that the Antarctic bottom water moves northward in a layer about 1 km. thick and mixes with the layers above. It was further assumed that radium-226 is released from the sea floor and mixes into the north-moving water. As radium decays at a constant rate and the approximate release of water is known, if a steady state is assumed, it is possible to estimate the relationship between the vertical eddy diffusivity and the total renewal time of bottom water. This relationship is dependent upon the difference in radium content of the inflowing and outflowing bottom water.

The results do not give exact values for renewal time or eddy diffusion but do permit an estimation of maximum values. Results indicate that eddy diffusivity in bottom water cannot be more than about 30 cm^2/sec, in which case the renewal time would be very long, i.e. longer than 2000 years. If it is assumed, however, that the eddy diffusivity is zero (very unlikely and resulting in the other extreme value), the renewal time could not be less than 50 years.

The actual values of renewal time and diffusion constant cannot be determined by this method. It seems, on the other hand, that a value of 20 to 25 cm^2/sec for eddy diffusivity may be a reasonable value, resulting in an equally reasonable renewal time of approximately 200 to 400 years.



Relationship of renewal time of
bottom water to vertical eddy diffusivity

Publication

KOCZY, F.F. and Barrey Szabo
1962. Renewal time of bottom water in the Pacific and Indian Oceans. Com. Vol. 20th Ann. Oceanographical Society of Japan, pp. 590-599.

Data Reduction - Saul Broida and Donald Eger

The acquisition of the 1620 Data Processing System, the 407 Accounting Machine, the card sorting machine, and the Calcomp 560 Graph Plotter now enables this section to reduce and process data with the following programs, most of which were written by the computer group:

1. Automatic temperature and depth computations. More than 70,000 individual temperatures and depths have been computed from data collected from various sources.

2. Routine in situ computations for density, specific volume anomaly, oxygen per cent saturation, and sound velocity.

3. Salinity-bridge calibration.

4. Turbulent diffusion.

5. Dynamic computations.

6. Data-processing phases of the Routine Chemistry Laboratory. These programs resulted in a 50 per cent saving of time for alkalinity and salinity determinations.

7. Various routine programs for processing of underwater acoustical data collected at the Institute's Bimini station.

8. Composite graph-plotting program for the automatic plotting of oceanographic station curves; e.g., temperature vs. depth, salinity vs. temperature, sigma-t vs. depth, specific volume anomaly vs. depth, oxygen and phosphates vs. temperature, and sound velocity vs. depth. The entire stations are plotted in approximately four minutes. This operation previously required several hours of tedious work by two or more persons for each station with no guarantee of the accuracy that is now assured.

Publications

A report of data obtained in Florida Straits and off the west coast of Florida. July - December 1961. Marine Laboratory Technical Report 62-6 submitted to the Office of Naval Research.

A report of data obtained in Florida Straits and off the west coast of Florida. January - June 1962. Marine Laboratory Technical Report 62-11 submitted to the Office of Naval Research.

<u>A Doppler Current Meter</u> - F.F. Koczy, Morton Kronengold, Jack Loewenstein

A current meter using the Doppler shift principle was designed, assembled, and tested in model tanks and in the ocean.

It consists of a transmitting and receiving transducer pair operating on a five mc acoustical signal. A very narrow beam is generated by use of a transmitting surface of one-inch diameter. The transmitted and reflected frequencies, which differ by the Doppler shift, are mixed in a superheterodyne receiver and the resulting beat frequency is proportional to the velocity of reflecting surfaces in water. This may be recorded on tape or read directly on a frequency meter. The reflecting volume may be controlled by choosing beam width, crossover point, and geometric arrangement of transducer.

The instrument was tested in a towing tank, off a dock area, and in the open ocean. The reflecting surfaces may consist of planktonic organisms, sediment particles, or air bubbles moving with the water. In the tank where a homogeneous cross-section was encountered, no reflection occurred except near the surface after the water was stirred vigorously.

Two modes of application are envisioned. It can serve as a current meter giving the average velocity or as a turbulence meter if the complete structure of the beat frequency is analyzed.

Publication

KOCZY, F.F., M. Kronengold, and Jack Loewenstein
1962. A doppler current meter. Marine Sciences Instrumentation
2:127-134.

Instruments and Devices - Shale J. Niskin

1. A five-liter nonmetallic water sampler was designed and five prototypes were fabricated and field tested. Twelve additional samplers were subsequently fabricated and are presently in use. Thirteen more are presently in the process of fabrication.

2. A large volume water sampler (100 gals. +) was designed and a prototype constructed and sea tested. A second sampler was then fabricated, sea-tested, and modified.

3. Seven 30-liter water samplers were rebuilt, employing a simplified tripping mechanism.

4. A stainless-steel, three-liter water sampler employing disposable plastic containers was designed for trace element, metal ion, and chemical analyses. Reversing thermometer mechanisms may be attached to this sampler.

5. A single-trip net closing device was designed and one prototype constructed and field tested. Six additional mechanisms have since been cast and are in current use.

6. A double-trip, opening and closing mechanism plus general modifications were designed for plankton nets. A prototype mechanism was fabricated and field tested. Six mechanisms were subsequently fabricated and are now in routine use at sea. Five additional devices are now being fabricated.

7. A new type of messenger (single piece) was designed, fabricated, and field tested. Twelve messengers were then fabricated. These messengers are presently in use with the double-trip mechanism (see point 6). Ten additional messengers are now being fabricated.

8. A new and simplified wire clamp was designed and field tested. Twelve such clamps are now used routinely at sea with the single- and double-trip mechanisms and other devices. Five additional wire clamps are being fabricated.

9. A nonmetallic, thermometer-reversing mechanism for attachment to any nonreversing type water sampler was designed. Three prototype mechanisms were fabricated, one for attachment to the five-liter, nonmetallic sampler and the remaining two for the sterile biosamplers. This mechanism has been extensively sea tested, and the remaining 29 nonmetallic samplers are currently being equipped with these mechanisms.

1. Modified sterile 3-liter Biosampler, disposable plastic container and metal frame.

2. Tripped thermometers in process of reversing.

3. Single trip plankton net closing mechanism.

4. Double release plankton net opening-closing mechanism and plankton net arrangement.

5. Water sampler prior to rolling.

Publication

NISKIN, Shale J.
1962. A water sampler for microbiological studies. Deep-Sea Research 9:501-503.

Submitted for publication

NISKIN, Shale J.
New collecting and recording devices for limnological and oceanographic research.

MARINE OPERATIONS

Marine Operations - Murice O. Rinkel, Richard O'Brien

The following is a consolidated table showing the use of ships on the ONR contracts during the period 1 June 1962 - 31 May 1963:

	NONR-840(01)	NONR-4008(02)
GERDA	72	54
ARIUS	1	1
CALAMUS	3	3
YAWLCAT		4 1/2
SAGITTA		1
	76 days	63 1/2 days

TOTAL: 139 1/2 days

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